CMT2300AW RSSI Usage Guideline

Summary

This document introduces the RSSI function, include relevant register, using guideline and how to calibrate it.

The part numbers covered by this document are as shown below.

Table 1. Part Numbers Covered by This Document

Part No.	Frequency	Modem	Function	Configuration	Package
CMT2300AW	127 - 1020MHz	(G)FSK/OOK	Transceiver	Register	QFN16

Before reading this document, it is recommended that reading the《AN142 - CMT2300AW Quick Start Guideline》, that will be make it easy to understand.

Content

1. The measurement and comparison of RSSI

The purpose of RSSI measurement is to let the user to be able to accurately read the current received signal strength. The received signal strength can be evaluated to the certain extent communication distance, when the transmitted power of Tx side is fixed.

RSSI comparison is means that is compared the current RSSI value with the threshold value. In this way, it can generate a indication from the comparative result. The indication is mapping to the RSSI_VLD interrupt to the MCU, and also used inside for the SLP function.

1.1 Register of RSSI Measurement

The corresponding interface and parameter in RFPDK as shown below:

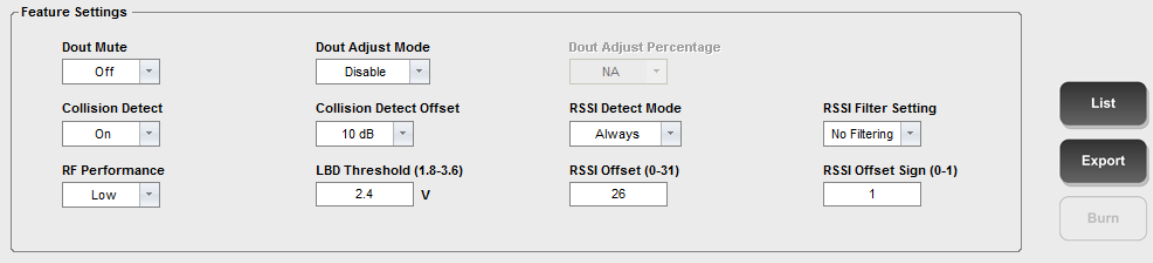

Figure 1. RSSI in RFPDK

Table 2. RSSI Related Parameters

Option Name in RFPDK	Bits in Register
RSSI Offset Sign	RSSI_OFFSET_SIGN
RSSI Offset	RSSI_OFFSET<4:0>
RSSI Detect Mode	RSSI_DET_SEL<1:0>
RSSI Filter Setting	RSSI_AVG_MODE<2:0>

The contents and meaning of the registers as shown below:

Table 3. RSSI Related Register in Config Bank

Register Name	Bit	R/W	Bit Name	Function Description
CUS_CMT9 (0x08)	7	RW	RSSI_OFFSET_SIGN	The sign of the RSSI measurement offset compensation
CUS_RSSI (0x0B)	7:3	RW	RSSI_OFFSET<4:0>	The value of the RSSI measurement offset
CUS_SYS11 (0x16)	4:3	RW	RSSI_DET_SEL<1:0>	RSSI detect time： 0：always 1：only done when PREAM_OK active 2：only done when SYNC_OK active 3：only done when PKT_OK active

Register Name	Bit	R/W	Bit Name	Function Description
	2:0	RW	RSSI_AVG_MODE<2:0>	The average filter type of RSSI measurement: 0：none 1：4th order 2：8th order 3：16th order 4：32th order

Table 4. RSSI Related Register in Control Bank2

Register Name	Bit	R/W	Bit Name	Function Description
CUS_RSSI_CODE (0x6F)	7:0	RW	RSSI_CODE<7:0>	RSSI ADC value, the output of SAR ADC after filtering, no unit, is an 8-bit codes.
CUS_RSSI_DBM (0x70)	7:0	RW	RSSI_DBM<7:0>	RSSI calculated value, after deducting 128 is equivalent to the input power from antenna, the unit is dBm. It is the SAR ADC value after filtering, and then be calculated to dBm unit.

1.2 RSSI measurement and comparison in FSK mode

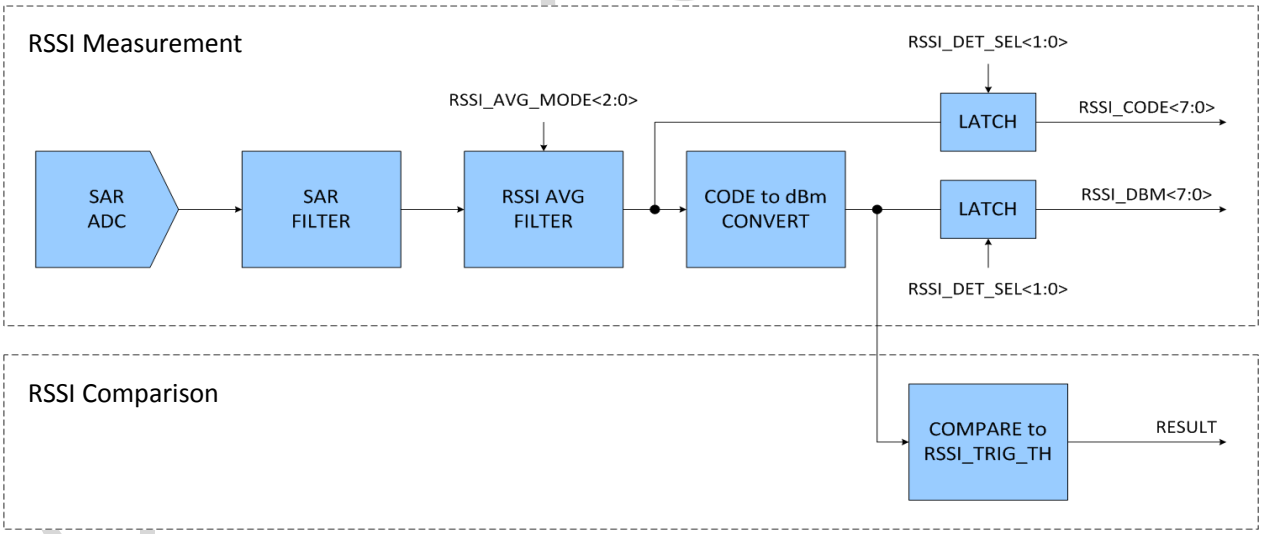

Figure 2. RSSI measurement and comparison chart in FSK mode

RSSI measurement has several steps, firstly the SAR_ADC converts the current received signal strength to digital code, an 8-bit code, and then through the first-order of SAR_FILTER for filtering, obtain a relatively smooth RSSI code values. Then will pass to the second-order RSSI_AVG_FILTER for further smoothing filtering, the order of filter is depend on the RSSI_AVG_MODE <2:0 >, which is set by the user. After smooth filtering, converting code value in dBm. Finally, the SAR_ADC values and calculated values will be sent to

register for conditional latches, latch condition depend on RSSI_DET_SEL<1:0>. The user can directly read out from the register.

RSSI comparison is means that, compare the current RSSI to the 'RSSI_TRIG_TH<7:0>-128' (RSSI_TRIG_TH is a threshold, which is set by the user), if is high than threshold, it is output 1; otherwise, it is output 0. And it is effecting the RSSI_VLD.

How to choose the order of the filter:

The filtering order is related with the symbols number, if filtering order is choose higher, it is need more symbols to get a correct RSSI values, so that is take more time to do smoothing filtering. But it is also limited by some condition, for example, RX_PREAM_SIZE = 16, and RSSI_DET_SEL<1:0> = 1 (It means RSSI only detect when PREAM_OK active), so that the filtering order should be not higher than 16th order to get a correct RSSI values. That is because of before the PREAM_OK is active, there is only 16 symbols as preamble to be received, just enough to do a 16th smoothing filtering. So it is better to set the filtering order less than RX_PREAM_SIZE. In the same way, if the RSSI_DET_SEL is SYNC_OK or PKT_OK, it is also need to make sure that the received symbols is enough to do smoothing filtering before the interrupt active.

CMT2300AW provided two kinds RSSI value:

RSSI_CODE, is a 8-bit code which is got from SAR-ADC convert code value;

RSSI_DBM, is units of dBm. It has better dynamic range, we recommend to used it.

1.3 RSSI measurement and comparison in OOK mode

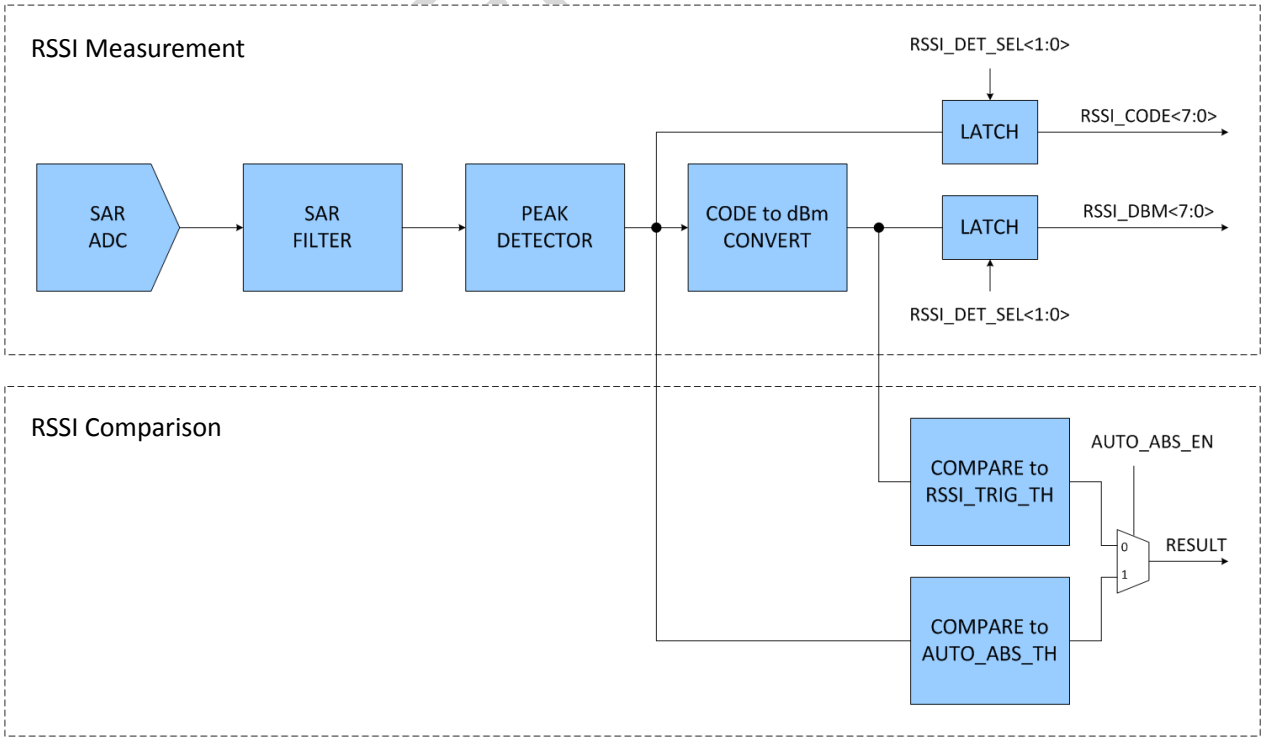

Figure 3. RSSI measurement and comparison chart in OOK mode

Because OOK is amplitude modulation, RSSI is unstable because of the data flow, so it is not satisfied to the user. The user is need a stable RSSI, so that CMT2300AW is detecting the peak signal strength for the RSSI value, and mapping to the register. This is called PEAK_DETECTOR.

There is two kinds comparison of OOK mode, one just the same way of FSK mode, another is called automatic absolute threshold. It is enabled by setting AUTO_ABS_EN. Once enable this function, CMT2300AW is automatically generating a threshold for masking the noise, which is comparing with the PEAK_DETECTOR value.

The absolute threshold is automatically generated, because of it can automatically masking the noise. CMT2300AW demodulate always hold output '0', when it does not receive any signal. Another advantage is that the result of the RSSI comparison can be used to assist the SLP function. But the disadvantaged is that CMT2300AW will lose 12dB receiving sensitivity.

1.4 RSSI Measured Results Compensation

Normally, the user just need to read out the value from the RSSI_DBM, then minus the 128, and there is the result of RSSI measurement.

$$\text{RSSI @ RF\_Input} = \text{RSSI\_dBm<7:0>} - 128$$

But in some cases, when the user need a more precise RSSI measurement, It need to do some more calibration after the chip was soldering on board.

The calibration work involves using the RSSI_OFFSET<4:0>, RSSI_OFFSET_SIGN, and RSSI_CODE<7:0>, this three registers. The method firstly to let the chip go to the receive mode, set the RSSI_OFFSET=0 and RSSI_OFFSET_SIGN=0, and then give a sine wave to the RFIN directly, about -90dBm from the signal generate equipment. After that, the MCU read out the value of RSSI_CODE<7:0>, and calculate according to the formula as shown below, at the end update RSSI_OFFSET and RSSI_OFFSET_SIGN.

$$\text{RSSI\_OFFSET<4:0>} = |\text{RSSI\_CODE<7:0>} - 91|$$

$$\text{RSSI\_OFFSET\_SIGN} = \begin{cases} 1, \text{When RSSI\_CODE<7:0>} - 91 > 0 \\ 0, \text{When RSSI\_CODE<7:0>} - 91 < 0 \end{cases}$$

After calibration, the RSSI measurement between -128dBm to +20dBm monotone increasing, between -100dBm to -50dBm linearity is better, in this range can reach the precision of +/- 3db.

2. Document Modification Record

Table 5. Document Modification Record Sheet

Version	Chapter	Modification descriptions	Date
0.9	All	Initial release	2017-08-21

3. Contact Information

Wuxi CMOSTEK Microelectronics Co., Ltd. Shenzhen branch
Room 203, Honghai Building, Qianhai Road, Nanshan District, Shenzhen, Guangdong, China

Zip Code： 518000
Tel： +86 - 755 - 83235017
Fax： +86 - 755 - 82761326
Sales： sales@cmostek.com
Technical support: support@cmostek.com
Website： www.cmostek.com